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FRONT-OPENING UNIFIED POD AUTO-LOADING STRUCTURE

BACKGROUND OF THE INVENTION

Field of the Invention:

The present invention relates to a FOUP (front-opening unified pod) auto-loading structure and, more particularly, to such FOUP auto-loading structure, which is suitable for use in the loading-in interface in a wafer manufacturing process to automatically close/open the cover of a FOUP.

Brief Description of the Prior Art:

In the fabrication of wafers, wafers are put in a unified pod, and the purity of the small inside space of the unified pod is well controlled. Because the purity of the small inside space of the unified pod is well controlled, the purity of the cleaning room is less critical. This measure saves much wafer manufacturing equipment cleaning cost. However, external dust or human body dust may be carried in the manufacturing equipment when opening the cover of the unified pod, causing a contamination to wafers.

SUMMARY OF THE INVENTION

The invention has been accomplished to provide a FOUP auto-loading structure, which eliminates the aforesaid problem. It is the main object of the present invention to provide a FOUP auto-loading structure, which automatically loads in and

opens/closes the FOUP, preventing a contamination to wafers. It is another object of the present invention to provide a FOUP auto-loading structure, which forms a part of the automation of the wafer manufacturing process.

To achieve the aforesaid objects and according to one aspect of the present invention, the FOUP auto-loading structure of the present invention comprises a machine base, the machine base comprising a backboard, a table on the middle of the backward, and a base at a bottom side of the backboard, the backboard having an access on an upper side of the backboard; a carriage supported on the table and adapted to carry a FOUP, the carriage having an elongated hole through top and bottom sidewalls thereof; a sliding control mechanism mounted on the table to support the carriage and controlled to move the carriage on the table toward or away from the access; a clamp mechanism mounted on the bottom sidewall of the carriage, the clamp mechanism comprising a rail fixedly fastened to the bottom sidewall of the carriage, a screw rod disposed in parallel to the rail of the clamp mechanism, a slide threaded onto the screw rod of the clamp mechanism and adapted to move along the rail of the clamp mechanism upon rotary motion of the screw rod of the clamp mechanism, a motor adapted to rotate the screw rod of the clamp mechanism clockwise/counter-clockwise, and a clamp plate fixedly mounted on the slide of the clamp

mechanism and inserted through the elongated hole of the carriage and adapted to be moved with the slide of the clamp mechanism to clamp the FOUP being carried on the carriage; a horizontal shifting mechanism, the horizontal shifting mechanism comprising rail means fixedly mounted on the base of the machine base, a horizontal screw rod disposed in parallel to the rail means of the horizontal shifting mechanism, a platform threaded onto the screw rod of the horizontal shifting mechanism, and a motor drive controlled to rotate the screw rod of the horizontal shifting mechanism clockwise/counter-clockwise for causing the platform to be moved horizontally along the rail means of the horizontal shifting mechanism toward/away from the backboard of the machine base; and a lifting mechanism, the lifting mechanism comprising a motor and a screw rod and slide set vertically mounted on the platform of the horizontal shifting mechanism, the screw rod and slide set comprising a vertical rail, a screw rod longitudinally mounted in the vertical rail, a slide threaded onto the screw rod of the lifting mechanism and moved along the vertical rail upon rotary motion of the screw rod of the lifting mechanism. According to another aspect of the present invention, the FOUP auto-loading structure further comprises a cover close/open control mechanism moved with the slide of the lifting mechanism and controlled to close/open the cover of the FOUP being carried on the

carriage. According to still another aspect of the present invention, the cover close/open control mechanism comprises: a gate fitting and adapted to be moved in and out of the access of the backboard of the machine base, the gate having two through holes; two racks respectively fixedly fastened to a back sidewall of the gate, two support arms respectively extended from the racks and connected to the slide of the lifting mechanism; and a driving unit mounted on a back sidewall of the gate and controlled to close/open the cover of the FOUP being carried on the carriage, the driving unit comprising a transmission shaft, a motor controlled to rotate the transmission shaft, two rotary bolts respectively coupled to the transmission shaft and inserted through the through holes of said gate and adapted for engaging into the locating holes for turning by the transmission shaft to close/open the cover of the FOUP being carried on the carriage. According to still another aspect of the present invention, carriage comprises an escape hole, a motor fixedly mounted on a bottom sidewall thereof, and a locking bolt inserted through the escape hole and coupled to the motor at the carriage and rotated by the motor at the carriage to lock the FOUP on the carriage.

Other objects, advantages, and novel features of the invention will become more apparent from the following detailed description when taken in conjunction with the accompanying

drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of a FOUP auto-loading structure according to the present invention.

FIG. 2A is an exploded view of a part of the present invention, showing the arrangement of the clamp mechanism, the locking bolt and locking bolt control motor, the sliding control mechanism, and the table.

FIG. 2B is a sectional view of a part of the present invention, showing the arrangement of the clamp mechanism, the locking bolt and locking bolt control motor, and the sliding control mechanism between the carriage and the table.

FIG. 3 is a perspective view of the lower part of the present invention, showing the arrangement of the horizontal shifting mechanism and the lifting mechanism.

FIG. 4 is a perspective backside view of a part of the present invention, showing the arrangement of the lifting mechanism, the horizontal shifting mechanism, and the cover close/open control mechanism.

FIG. 5 is a perspective view in an enlarged scale of the upper part of FIG. 4.

FIG. 6 is a schematic drawing showing the operation of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. 1, a FOUP (front-opening unified pod) **8** is shown comprising an opening **81**, a cover **82** that closes the opening **81**, and a bottom panel **83**. The cover **82** has two locating holes **821** and **821'**. The bottom panel **83** comprises a positioning hole **831** at the center, a retaining portion **832** at a front side. The invention is used to load and open/close the cover **82** of the FOUP **8**.

The machine base, referenced by **1**, comprises a backboard **11** fixedly fastened to the loading port of the manufacturing equipment **9**. The back board **11** has a table **12** transversely disposed on the middle, a base **13** fixedly provided at the bottom side thereof, an access **110** disposed on the upper side of the backboard **11** above the table **12**, two parallel sliding slots **111** and **112** longitudinally vertically disposed below the table **12** (see also FIG. 4), and a packing member **113** fastened to the border of the access **110** at the front side and adapted to match with the opening **81** of the FOUP **8**.

The carriage, referenced by **2**, comprises three upright locating pins **201** disposed corresponding to three positioning grooves **833** of the bottom panel **83** of the unified pod **8** for the positioning of the FOUP **8** on the carriage **2**, two first upright detection pins **202** and **202'** corresponding to two recessed holes

834 and 834' on the bottom panel 83 of the FOUP 8 for detecting the front-stage manufacturing process or rear-stage manufacturing process, two second upright detection pins 203 and 203' corresponding to inspection holes 835 and 835' on the bottom panel 83 of the FOUP 8 for detecting the type of the unified pod 8 to be the 13-piece unified pod or 25-piece unified pod, and a third upright detecting pin 206 (see FIG. 2B). If the FOUP 8 does not match the upright detection pins 201, 202 and 203', the bottom panel 83 is tilted and cannot force down the third upright detection pin 206. In this case, it means that the FOUP 8 is not correctly positioned. The carriage 2 further comprises an escape hole 204, and an elongated hole 205.

FIG. 2A shows the carriage 2 supported on a sliding control mechanism 21 above the table 12. The sliding control mechanism 21 comprises two parallel rails 22 and 22' fixedly mounted on the table 12, a front limit switch 221 and a rear limit switch 221' respectively disposed at front and rear ends of one rail 22, two slides 23 and 23' fixedly fastened to the bottom side wall of the carriage 2 and moved with the carriage along the rails 22 and 22', a screw rod 25 fixedly mounted in the table 12, and a reversible motor 24 adapted to rotate the screw rod 25 clockwise/counter-clockwise. One slide 22 is threaded onto the screw rod 25. When starting the reversible motor 24 to rotate the

screw rod **25** clockwise or counter-clockwise, the carriage **2** is moved with the slides **23** and **23'** along the rails **22** and **22'** toward or away from the access **110**.

Referring to FIG. 2B and FIG. 2A again, a locking bolt control motor **31** and a clamp mechanism **4** are fixedly fastened to the bottom sidewall of the carriage **2**. A locking bolt **3** is inserted through the escape hole **204** of the carriage **2**, having a front end protruding over the topside of the carriage **2** for inserting into the positioning hole **831** on the bottom panel **83** of the FOUP **8** and a rear end coupled to the locking bolt **3**. After insertion of the locking bolt **3** into the positioning hole **831** on the bottom panel **83** of the FOUP **8**, the locking bolt control motor **31** is operated to rotate the locking bolt **3** through 90° angle to lock the FOUP **8**. Limit switches **311** and **311'** are provided to control forward/backward turning operation of the motor **31** through 90°. The front limit switch **221** and rear limit switch **221'** control the locking bolt control motor **31** to rotate 90° forwards or backwards, so as to turn the unlock the locking bolt **3** between the locking position and the unlocking position. The clamp mechanism **4** comprises a rail **41** fixedly fastened to the bottom sidewall of the carriage **2**, a screw rod **44** disposed in parallel to the rail **41**, a slide **42** threaded onto the screw rod **44** and moved along the rail **41** upon rotary motion of the screw rod **44**, a front limit switch **411** and a

rear limit switch **411'** respectively mounted on the front and rear ends of the rail **41**, a motor **43** controlled to rotate the screw rod **44**, and a clamp plate **45** fixedly mounted on the slide **42** and inserted through the elongated hole **205** of the carriage **2** and adapted to clamp the retaining portion **832** of the bottom panel **83** of the FOUP **8**. Rotating the motor **43** clockwise/counter-clockwise causes the clamp plate **45** to be moved with the slide **42** forwards or backwards, and therefore the clamp plate **45** is pressed on or released from the retaining portion **832** of the bottom panel **83** of the FOUP **8**. Further, plastic rollers **46** are bilaterally provided at the topside of the clamp plate **45**, which prevent damage to the retaining portion **832** upon pressing of the clamp plate **45** on the retaining portion **832**, and eliminate the production of dust due to friction between the retaining portion **832** and the clamp plate **45**.

Referring to FIG. 3, a horizontal shifting mechanism **5** and a lifting mechanism **6** are respectively installed in the base **13** of the machine base **1**. The horizontal shifting mechanism **5** comprises two rails **51** and **51'** horizontally arranged in parallel and extended perpendicular to the backward **11**, a front limit switch **511** and a rear limit switch **511'** respectively provided at the front and rear ends of one rail **51**, a horizontal screw rod **53** disposed above the elevation of and in parallel to the rails **51** and **51'**, a platform **52** threaded onto the screw rod **53** and slidably supported on the rails

51 and 51', and a motor drive 54 controlled to rotate the screw rod 53 clockwise/counter-clockwise. Rotating the screw rod 53 clockwise/counter-clockwise causes the platform 52 to be moved horizontally forwards/backwards along the rails 51 and 51' relative to the backboard 11. The lifting mechanism 6 comprises a screw rod and slide set 61 and a motor 65 vertically mounted on the platform 52 of the horizontal shifting mechanism 5. The screw rod and slide set 61 comprises a vertical rail 62 of U-shaped cross section having an open side facing to the outside, two guide rods 621 perpendicularly extended from the back sidewall of the vertical rail 62 and inserted through respective guide holes 114 on the backboard 11 and adapted to guide horizontal movement of the vertical rail 62 with the platform 52, a screw rod 64 longitudinally mounted in the vertical rail 62, a slide 63 threaded onto the screw rod 64 and moved along the vertical rail 62 upon rotary motion of the screw rod 64, and a limit switch 622 mounted in the vertical rail 62 and adapted to limit down stroke of the slide 63. The motor 65 is controlled to rotate the screw rod 64 clockwise/counter-clockwise, causing the slide 63 to be moved upwards/downwards along the vertical rail 62.

Referring to FIGS. 4 and 5 and FIG.1 again, a cover close/open control mechanism 7 is provided at the backside of the backboard 11. The cover close/open control mechanism7 comprises

a gate **71** fitting the access **110** of the backboard **11**, a packing member **712** fastened to the border of the gate **110** at the front side and adapted to match with the cover **82** of the FOUP **8**, the gate **71** comprising two front positioning pins **713** adapted to engage the recessed positioning holes **822** and **822'** on the cover **82** of the FOUP **8** and to stop the FOUP **8** from displacement and two through holes **711** corresponding to the locating holes **821** and **821'** of the cover **82** of the FOUP **8**, two racks **72** and **72'** fixedly fastened to the back sidewall of the gate **71** and arranged in parallel, two support arms **73** and **73'** respectively forwardly extended from the racks **72** and **72'** below the gate **71** and inserted through the sliding slots **111** and **112** of the backboard **11** and fixedly connected to the slide **63** of the screw rod and slide set **61** of the lifting mechanism **6** for enabling the gate **71** to be moved horizontally and vertically by the horizontal shifting mechanism **5** and the lifting mechanism **6**, and a driving unit **74** mounted on the back sidewall of the gate **71** and controlled to close/open the cover **82** of the FOUP **8**. The driving unit **74** comprises a transmission shaft **76**, a motor **75** controlled to rotate the transmission shaft **76**, two rotary bolts **77** and **77'** respectively coupled to the transmission shaft **76** and inserted through the through holes **711** of the gate **71** and adapted for engaging into the locating holes **821** and **821'** of the cover **82** of the FOUP **8** to open the cover **82** from the opening **81** of the FOUP

8. Further, at least one, for example, two detectors **78** are provided at the topside of the gate **71**. After removal of the cover **82** from the opening **81** of the FOUP **8**, the detectors **78** are moved with the gate **71** up and down relative to the FOUP **8** to detect the number and positioning of the wafers in the FOUP **8**. There is also provided a detector **79** mounted on the back sidewall of the backboard **11** above the access **110**, and adapted to detect protrusion of wafers in the FOUP **8**, so as to prevent damage to the wafers upon closing/opening of the cover **82**.

As stated above, when the FOUP **8** is carried to the carriage **2** by labor or an automatic truck, the correct positioning of the FOUP **8** is detected by the upright detection pins **202** and **203**, and then the third upright detection pin **206** is pressed down to turn on the motor **31**, causing the motor **31** to rotate the locking bolt **3** in one direction through 90°, and therefore the locking bolt **31** is forced into engagement with the positioning hole **831** on the bottom panel **83** of the FOUP **8**. At the same time, the motor **43** of the clamp mechanism **4** is turned on to rotate the screw rod **44**, causing the clamp plate **45** to be moved with the slide **42** and forced into engagement with the retaining portion **831** of the bottom panel **83** of the FOUP **8**. This double-locking effect keeps forward movement of the FOUP **8** in course. The sliding control mechanism **21** is then driven to move the carriage **2** and the FOUP **8** forwards, causing the

opening **81** of the FOUP **8** to be forced into close contact with the packing member **113** of the access **110**. Therefore, when the motor **75** of the driving unit **74** is started to rotate the rotary bolts **77** and **77'** in opening the cover **82**, the FOUP **8** is maintained free from contamination. Thereafter, the horizontal shifting mechanism **5** is operated to move the cover **82** horizontally backwards, and then the lifting mechanism **6** is operated to lower the cover **82**, for allowing the internal mechanical arm of the manufacturing equipment **9** to pick up the wafers from the FOUP **8**. On the contrary, when closing the cover **82** on the FOUP **8**, the aforesaid procedure is repeated reversely. Therefore, the FOUP **8** can be automatically opened and closed in the manufacturing equipment **9** without causing contamination.

Although the present invention has been explained in relation to its preferred embodiment, it is to be understood that many other possible modifications and variations can be made without departing from the spirit and scope of the invention as hereinafter claimed.